

AGRICULTURAL DRAINAGE CONTRIBUTION TO WATER QUALITY  
IN THE GRASSLAND AREA OF WESTERN MERCED COUNTY,  
CALIFORNIA: October 1987 through September 1988

California Regional Water Quality Control Board  
3443 Routier Road, Sacramento, California 95827-3098  
Central Valley Region

May 1989

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD  
CENTRAL VALLEY REGION

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## EXECUTIVE SUMMARY AND RECOMMENDATIONS

### SUMMARY

In May 1985, Regional Board staff began a water quality monitoring program to evaluate the effects of subsurface agricultural drainage on the water quality of the drains in the Grassland Area of western Merced County. The purpose of this monitoring program was to compile an on-going database for selected inorganic constituents found in the agricultural drains discharging to and flowing through the Grassland Area. This database will be used in the development and evaluation of future agricultural drainage reduction programs in the San Joaquin River Basin. A report on this water quality survey has already been prepared and approved by the Board for May 1985 through March 1988. The current report covers October 1987 through September 1988, a time period which includes critical Water Year 1988, and provides a long-term data base for assessing the effects of future regulatory actions.

Agricultural lands east, west, and south of the Grassland Area discharge subsurface agricultural drainage water (tile drainage) and surface runoff (irrigation tailwater) to the Grassland Area. This drainage often contains high concentrations of salts, selenium, and other trace elements. This regional drainage flows north through the Grassland Area where it is carried by a network of canals which can divert water in a number of possible ways before it reaches Mud or Salt Sloughs and ultimately the San Joaquin River. A water quality monitoring network was established to ensure measurement of inflows to the Grassland Area, internal flows within the Grassland, and outflows to the San Joaquin River.

The current study shows that water quality continues to vary widely with the highest constituent concentrations found at the inflow monitoring stations near the southern boundary of the study area. This inflow water is generally a blend of subsurface tile drainage and surface runoff (tailwater) or operational spills from irrigation canals. Four of these inflow points carry a substantial portion of subsurface drainage water. The highest concentrations at these four sites likely reflect a greater proportion of tile drainage in the flow and not necessarily the quality of subsurface drainage being discharged at the tile drainage sumps. The sites inflowing from the south and southeast continue to carry the highest concentrations of salts, boron, and selenium. Other inflows contain little selenium, however elevated levels of salt and boron are present. For example, the median values for selenium at the four major southern inflow points ranged from 49 to 71  $\mu\text{g/L}$  while other inflow points showed selenium values ranging from 1.2 to 7.9  $\mu\text{g/L}$ . For boron however, the four drains carrying the high selenium water showed median boron values ranging from 4.5 to 6.4  $\text{mg/L}$  while the other inflow drains that have low selenium values showed median boron values ranging from 0.38 to 8.6  $\text{mg/L}$ .

Concentration at the internal flow and outflow monitoring stations were comparable to each other and were substantially lower than the southern inflows. The water quality reflects the amount of mixing and dilution that takes place as drainage water moves through the Grassland Area. The flows are strongly regulated by an extensive system of man-made structures and trends in water quality are difficult to identify.

The two main outflows, Mud Slough (North) and Salt Slough were monitored during the study. These sites represent water quality of the blended drainage flowing from the Grassland Area to the San Joaquin River. The quality of both sloughs varied widely depending upon which slough was carrying the greatest portion of subsurface tile drainage water. Median concentrations for the two sloughs were similar although a wide range of variability was detected. For example, Salt Slough selenium concentrations ranged from 1.6 to 27  $\mu\text{g/L}$  with a median of 13  $\mu\text{g/L}$ . Mud Slough showed a similar variability with a

median selenium value of 9.3 µg/L. Concentrations for all the drains and sloughs were routinely higher during the critical Water Years 1987 and 1988 than they were during the wet Water Year 1986. Seasonal variations in constituent concentrations occurred in Water Year 1988 in a manner similar to the previous two Water Years, with the highest levels occurring during the nonirrigation season (October to March).

Analyses for total recoverable chromium were conducted on the major inflow and two outflow sites. The reported concentrations are appearing elevated with values ranging from 2 ug/L to 82 ug/L. Water quality guidelines and criteria have identified hexavalent chromium at concentrations greater than 11 ug/L as the only species of chromium to be a threat to beneficial uses.

## RECOMMENDATIONS

1. In cooperation with other agencies and dischargers, continue water quality monitoring at the inflow points to the Grassland Area in order to expand the database needed to evaluate the effectiveness of the drainage reduction programs being developed for the Western San Joaquin Valley;
2. Reduce or eliminate the internal flow stations within the Grassland Area as operation and management play a major role in their water quality;
3. In cooperation with other agencies, ensure continued water quality and flow monitoring at the two main outflow stations (Mud Slough (North) and Salt Slough) to the San Joaquin River;
4. Continuous flow monitoring equipment should be installed on any of the four main inflow drains to the South Grassland Area which are not presently gauged to aid evaluation of future agricultural drainage reduction programs in the San Joaquin River Basin;
5. A special study should be conducted to determine the presence of hexavalent chromium. Total recoverable chromium concentrations were elevated in this study. However, water quality guidelines and criteria identify hexavalent chromium as the only species of chromium to be a threat to beneficial uses.

## INTRODUCTION

The Agricultural Unit of the Central Valley Regional Water Quality Control Board (Regional Board) initiated a water quality monitoring program in May of 1985 to evaluate the effects of subsurface agricultural drainage on the water quality of the drains in the Grassland Area in western Merced County. The study area is located west of the San Joaquin River between Newman and Oro Loma, California (Figure 1). The purpose of this monitoring program was to compile an on-going database for selected inorganic constituents found in the agricultural drains discharging to and flowing through the Grassland Area. This database will be used in the development and evaluation of an agricultural drainage reduction program in the San Joaquin River Basin. This report contains laboratory results and a brief summary of the water quality analysis for samples collected from October 1987 through September 1988. A previous report (James et al., 1988) presented the data for the period May 1985 through March 1988. This report overlaps the previous report for a few months but is represented here to enable a discussion of the entire Water Year (WY) 88 which extends from October 1, 1987 through September 30, 1988.

## STUDY AREA

The Grassland Area is comprised of the Northern and Southern Divisions of the Grassland Water District and the farmlands adjacent to the District (Figure 1). Land in this area is primarily used for agriculture and seasonal wetlands.

Agricultural lands east, west, and south of the Grassland Area discharge subsurface agricultural drainage water (tile drainage) and surface runoff (irrigation tailwater) to the Grassland Area. This drainage often contains high concentrations of salts, selenium, and other trace elements. This regional drainage flows north through the Grassland Area where it is carried by a network of canals which can divert water in a number of possible ways before it reaches Mud or Salt Sloughs and ultimately the San Joaquin River.

There were 32 stations in the Grassland monitoring program as described by James et al., 1988. They were divided into three categories: inflows to, internal flows within, and outflows from the Grasslands. Inflow monitoring stations were located on drains that discharge into the Grassland area and are mainly located at the southern end of the study area. Monitoring stations on the internal flow canals were located on drains within the Grassland Area that carry or could carry subsurface tile drainage as it passes through the area before discharging to the San Joaquin River. Outflow monitoring stations were located where drains or natural waterways flow out of the Grassland Area. Many of the internal flow stations described by James et al., 1988, have been dropped from the monitoring program due to the large effect management plays in their water quality. The present report concentrates on the inflow and outflow stations. A list of the monitoring stations is shown in Table 1. Stations which have continuous data from May 1985 through December 1988 have been highlighted. The remaining stations were dropped from the monitoring program by February 1988 with the corresponding data reported in James et al., 1988. In this study, there are 11 inflow, 2 internal flow, and 7 outflow monitoring stations. The two internal flow stations are maintained to assess the approximate concentration of selenium in the two main water supply source canals to the Grassland Area. Table 1 also identifies the map index number for each site as shown on the location map in Figure 2.

## METHODS

The frequency of sample collection for this phase of the monitoring program varied, but generally grab samples were collected during the first week of each month and were analyzed

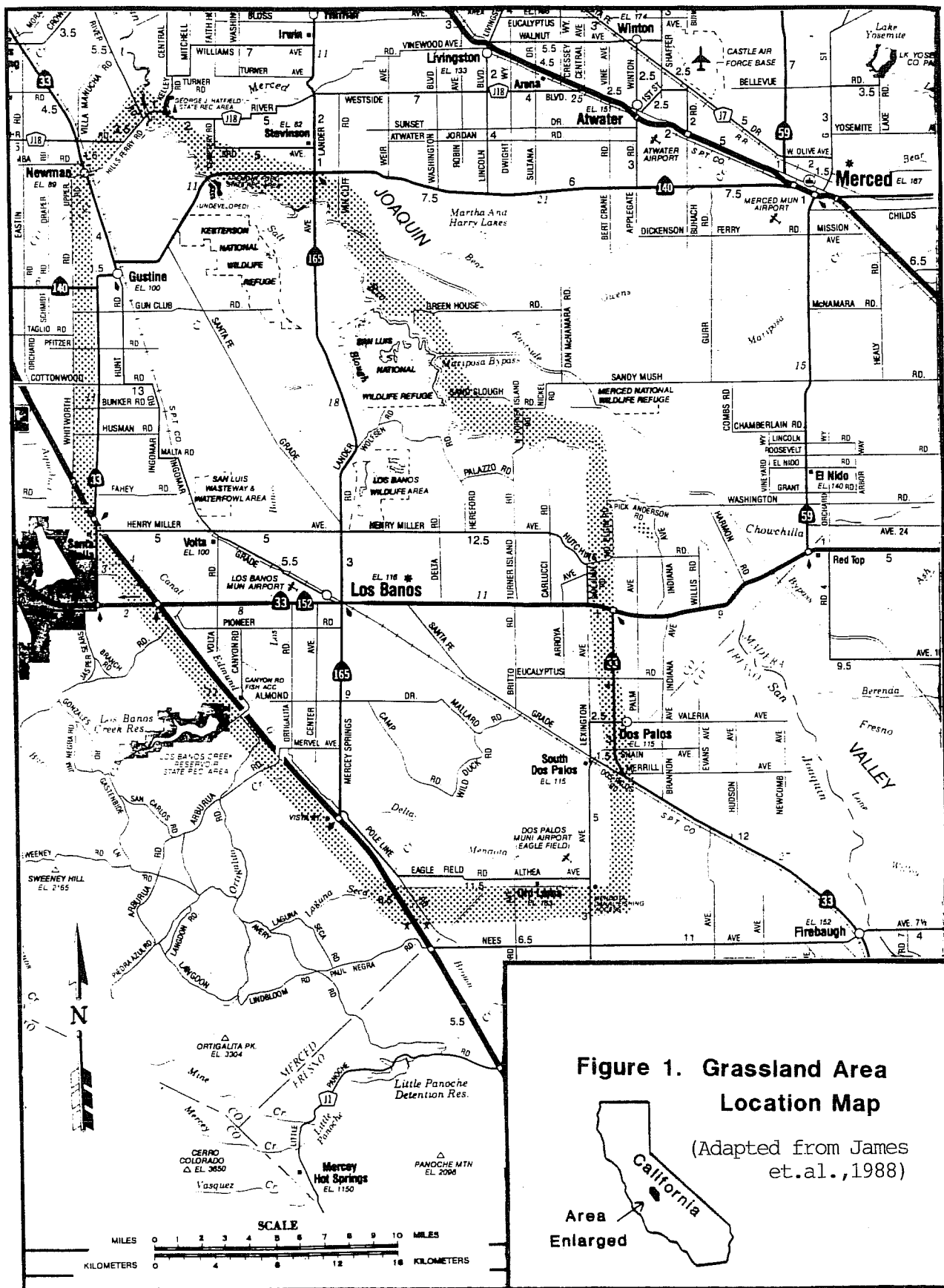


Table 1. Water quality monitoring Sites in the Grassland Area  
(adapted from James et al., 1988).

Map Index	RWQCB Site I.D.	Site Name	Site Type
I-1	MER556	Firebaugh @ Russell Avenue	Inflow
I-2	MER501	Panoche Drain	Inflow
I-3	MER552	Agatha Inlet (Mercy Springs) Drain	Inflow
I-4	MER506	Agatha Canal	Inflow
I-5	MER507	Helm Canal	Inflow
I-6	MER504	Hamburg Drain	Inflow
I-7	MER505	Camp 13 Slough	Inflow
I-8	MER502	Charleston Drain	Inflow
I-9	MER555	Almond Drive Drain	Inflow
I-10	MER509	Rice Drain	Inflow
I-11	MER521	Boundary Drain	Inflow
I-12	MER528	Salt Slough Ditch @ Hereford Road	Inflow
I-13	MER513	Garzas Creek @ Hunt Road	Inflow
T-1	MER510	CCID Main @ Russell Avenue	Internal Flow
T-2	MER511	CCID Main @ Almond Drive	Internal Flow
T-3	MER512	CCID Main @ Gun Club Road	Internal Flow
T-4	MER540	Santa Fe Canal @ HWY 152	Internal Flow
T-5	MER519	Santa Fe Canal @ Henry MNiller Rd.	Internal Flow
T-6	MER517	Santa Fe Canal @ Gun Club Rd.	Internal Flow
T-7	MER527	San Luis Canal @ HWY 152	Internal Flow
T-8	MER514	Los Banos Creek @ Gun Club Rd.	Internal Flow
T-9	MER518	Eagle Ditch	Internal Flow
T-10	MER516	Mud Slough (North) @ Gun Club Rd.	Internal Flow
T-11	MER515	Freemont Canal @ Gun Club Rd.	Internal Flow
T-12	MER553	Gustine Sewage Treatment Plant Ditch	Internal Flow
O-1	MER551	Mud Slough (N) @ Newman Gun Club	Outflow
O-2	MER541	Mud Slough (N) @ HWY 140	Outflow
O-3	MER554	Los Banos Creek @ HWY 140	Outflow
O-4	MER531	Salt Slough @ Lander Avenue	Outflow
O-5	MER530	Salt Slough @ Wolfsen Road	Outflow
O-6	MER543	City Ditch	Outflow
O-7	MER548	Santa Fe Canal-Mud Slough Diversion	Outflow

Bold print indicates that site has data for WY 88

for total recoverable selenium, boron, chloride, sulfate, total alkalinity, and electrical conductivity (EC). Selected inflow and internal flow monitoring sites were also sampled for total recoverable copper, chromium, lead, molybdenum, nickel, and zinc. Water temperature, pH, EC, and sample time were recorded in the field for each site. All samples were collected in polyethylene bottles. All the selenium and trace element sample bottles were washed and acid rinsed in the laboratory prior to use. All sample bottles were rinsed three times with the water to be sampled prior to sample collection. Selenium and trace element samples were preserved by lowering the pH to less than 2 using ultra-pure nitric acid fixation techniques. All samples were kept on ice until preservation or submittal to the laboratory.

A quality control and quality assurance program was conducted utilizing spike and duplicate samples in the laboratory. In addition, blind replicate samples were collected at 10 percent of

the sites, and 50 percent of the blind replicates were spiked for laboratory quality assurance. Reported results fall within quality assurance tolerance guidelines outlined in Regional Board laboratory quality control files.

## RESULTS

Following the trend described in James et al., 1988, the highest concentrations of the measured constituents were found at the inflow monitoring stations near the southern boundary of the study area. Concentrations at the internal flow and outflow monitoring stations were comparable to each other and were substantially lower than the southern inflows. Water quality analysis results at the inflow, internal flow, and outflow monitoring stations will be discussed separately.

Water quality results for both minerals and trace elements are listed by site in Appendices A through C; Grassland inflows (Appendix A), internal flows (Appendix B), and outflows (Appendix C). The ranges and median values for each measured constituent at each site are also shown in these appendices. For this study, electrical conductivity (EC), boron, chloride, and sulfate were the primary mineral constituents of concern. Selenium was the primary trace element of concern. The median mineral and trace element values at each inflow monitoring station are listed in Table 2 for WY 88 (October 1987 through September 1988). Values for City Ditch represent median concentrations for the time period October 1987 through June 1988, while values for Santa Fe Canal at Mud Slough Diversion represent monitoring conducted on a quarterly basis.

### Minerals

#### Inflow Monitoring Stations:

The inflow monitoring stations represent the quality of the agricultural drainage entering the Grassland Area as described in James et al., 1988. The first nine monitoring stations (I-1 to I-10) listed in Table 2 represent inflow into the South Grassland Area. The remaining two inflow stations (I-11 to I-12) either discharge to sloughs or the North Grassland Area (Figure 2).

Continuing the trend found in James et al., 1988, the inflows that carry a substantial portion of subsurface drainage water, the Firebaugh (I-1), Panoche (I-2), Agatha Inlet (Mercy Springs) Drain (I-3), Hamburg (I-6), and Charleston Drains (I-8), had elevated salinity levels. The Charleston Drain had the highest median EC (4450  $\mu\text{mhos/cm}$ ) and sulfate (1300 mg/L) values. The highest median boron and chloride concentrations (8.6 mg/L and 540 mg/L, respectively) occurred at the Agatha Inlet Drain.

#### Internal Flow Monitoring Stations:

The internal flow monitoring stations were located on drains that carry or could carry subsurface agricultural drainage as it passes through the Grassland Area as described in James et al., 1988. Only two of the original internal flow monitoring stations, the CCID Main at Russell Avenue (T-1) and the San Luis Canal at Highway 152 (T-7), were monitored during WY 88. These two stations represent concentrations in the main water supply source canals to the Grassland Area.

The median EC, boron, chloride, and sulfate values recorded during this study for each of the internal flow monitoring stations are listed in Table 2. The values for sites T-1 and T-7 were 760  $\mu\text{mhos/cm}$ , 0.29 mg/L, 120 mg/L and 65 mg/L, and 2550  $\mu\text{mhos/cm}$ , 3.6 mg/L, 280 mg/L, and 570 mg/L, respectively.

Table 2. Median Constituent Concentrations for Grassland Area Drains During WY 88 (10/87 through 9/88).

Map ID	Monitoring Site	umhos/cm	Median Constituent Concentrations									
			mg/L			ug/L						
		EC	B	Cl	SO4	Se	Mo	Cr	Cu	Ni	Pb	Zn
<b>Inflow Sites</b>												
I-1	Firebaugh Drain/Russell	3000	3.6	320	790	49	10	22	12	22	<5	29
I-2	Panoche Drain/O'Banion	3650	6.4	490	890	54	3.0	43	12	21	<5	29
I-3	Agatha Inlet Drain	4150	8.6	540	1300	7.9	39	10	5	15	<5	12
I-4	Agatha Canal	3550	5.6	430	895	39	2.5	-	-	-	-	-
I-6	Hamburg Drain	3600	4.6	530	1200	71	5.0	14	3	<5	<5	6
I-7	Camp 13 Slough	4400	6.2	500	1050	43	3.5	-	-	-	-	-
I-8	Charleston Drain	4450	4.5	520	1300	71	3.0	31	13	27	<5	47
I-9	Almond Drive Drain	2300	2.1	230	460	4.6	-	18	7	13	<5	15
I-10	Rice Drain	2750	5.1	310	700	2.6	15	-	-	-	-	-
I-11	Boundary Drain	1470	0.50	230	180	1.4	6.0	-	-	-	-	-
I-12	Salt Slough/Hereford	1150	0.38	160	140	1.2	5.0	-	-	-	-	-
<b>Internal Flow Sites</b>												
T-1	CCID Main Canal/Russell	760	0.29	120	65	1.7	-	-	-	-	-	-
T-7	San Luis Canal/HWY 152	2550	3.6	280	570	3.9	-	-	-	-	-	-
<b>Outflow Sites</b>												
O-1	Mud Slough / NGC	2480	2.2	330	440	4.7	-	-	-	-	-	-
O-2	Mud Slough/HWY 140	2820	2.7	350	510	9.3	11	-	-	-	-	-
O-3	Los Banos Creek/HWY 140	1650	1.2	230	210	1.1	-	-	-	-	-	-
O-4	Salt Slough/Lander Ave.	1940	1.9	260	385	13	6	-	-	-	-	-
O-5	Salt Slough/Wolfson Road	2200	2.2	280	460	14	-	-	-	-	-	-
O-6	City Ditch*	3280	4.4	380	810	39	-	18	18	35	<5	52
O-7	Santa Fe Canal/MSD*	2800	3.9	370	670	38	-	11	5	7	<5	9

All results are reported as total recoverable

\* = site has minimal data for WY 88

#### Outflow Monitoring Stations:

Mud and Salt Sloughs are the only two tributaries to the San Joaquin River which drain the Grassland Area and are described in detail in James et al., 1988, Pierson et al., 1989a, and Pierson et al, 1989b. Mud Slough (North) at Highway 140 (O-2) is a principle station in this monitoring program and, as does Salt Slough at Lander Avenue, best represents the water quality of the drainage leaving the Grassland Area. During this study, Mud Slough at Highway 140 had EC values ranging from 1550 to 5100  $\mu$ mhos/cm with a median of 2820  $\mu$ mhos/cm. Boron at this site ranged from 1.1 to 4.0 mg/L with a median value of 2.7 mg/L.

Salt Slough at Lander Avenue (O-4) is the last monitoring station before Salt Slough discharges to the San Joaquin River. During this study, Salt Slough at Lander Avenue had EC values ranging from 1480 to 3700  $\mu$ mhos/cm with a median value of 1940  $\mu$ mhos/cm, and boron values ranging from 0.66 to 3.9 mg/L with a median of 1.9 mg/L (Appendix C). EC and boron concentrations at this site are extremely variable because of the frequent

changes of water diversion patterns within the Grassland area, but concentrations at this site are generally lower than the South Grassland inflow monitoring stations due to additional dilution that occurs as the drainage water moves further downstream.

### Trace Elements

Although selenium was monitored at every site and molybdenum at a majority of sites, analyses of additional trace elements were limited based on the overall low concentrations found by James et al., 1988. Total recoverable selenium, molybdenum, copper, chromium, lead, nickel, and zinc are listed in Appendices A through C for inflow, internal flow, and outflow monitoring stations, respectively. The ranges and median concentrations for each measured trace element constituent at each monitoring station are also listed in these appendices. The median trace element concentrations at each of the stations for WY 88 are tabulated in Table 2. Values for City Ditch represent median concentrations for the time period October 1987 through June 1988. The drains are described in James et al., 1988, while values for Santa Fe Canal at Mud Slough Diversion represent monitoring conducted on a quarterly basis.

#### Inflow Monitoring Stations:

The highest median trace element concentrations occurred at the South Grassland inflow stations (I-1 to I-10), where the median selenium values ranged from 1.2 µg/L at Salt Slough at Hereford Road (I-12) to 70 µg/L at Charleston Drain (I-8) and Hamburg Drain (I-6). Firebaugh (I-1), Panoche (I-2), and Charleston Drains (I-8) had high median selenium concentrations, however, as with salinity and boron discussed earlier, the concentrations are highly dependent upon the amount of dilution water in the canal or drain at the time of sampling. Total recoverable selenium concentrations have been found in excess of 100 µg/L at Firebaugh Drain (3 times) and Panoche Drain (1 times) indicating that little surface runoff was available for dilution at that time. Selenium concentrations exceeded 100 ug/L at Camp 13 one time, peaking at 107 ug/L in May 1988. Camp 13 receives water from a mixture of drains including Firebaugh and Panoche. These higher concentrations occurred primarily during the non-irrigation season (October - March).

The Firebaugh Drain (I-1), Agatha Inlet (Mercy Springs) Drain (I-3), and Rice Drain (I-10) had the highest median molybdenum concentrations at 10 ug/L, 39 ug/L, and 15 ug/L, respectively. The remaining inflow drains had a median molybdenum concentrations ranging from 2.5 ug/L to 6 ug/L.

Total recoverable chromium, copper, nickel, lead, and zinc were monitored on six of the eleven inflow stations. The median total recoverable chromium concentrations ranged from 10 to 43 µg/L, with the highest concentrations occurring in drains that receive drainage from the south. The median total recoverable copper concentrations ranged from 3 to 13 µg/L at the inflow monitoring stations. Total recoverable nickel concentrations were slightly elevated. The highest median nickel concentrations occurred at Firebaugh, Panoche, and Charleston Drains (I-1, I-2, and I-8) at 22 ug/L, 21 ug/L, and 27 ug/L, respectively. Total recoverable lead concentrations were generally undetected at the 5 µg/L detection limit at all inflow monitoring stations. Slightly elevated total recoverable zinc concentrations were present in several of the inflow drains. Median zinc concentrations ranged from 6 to 47 µg/L.

#### Internal Flow Monitoring Stations:

Selenium was the only trace element measured at both internal flow monitoring stations. From October 1987 through December 1988, CCID Main Canal at Russell Avenue (T-1) had selenium concentrations ranging from 0.8 ug/L to 3.6 ug/L with a median concentration of

1.7 ug/L. During the same period, selenium concentrations at San Luis Canal at Hwy 152 (T-7) ranged from 1.3 ug/L to 7.9 ug/L with a median concentration of 3.9 ug/L.

#### Outflow Monitoring Stations:

Selenium was monitored at all seven outflow stations, molybdenum was monitored at two stations (O-2 and O-4), and copper, chromium, nickel, lead, and zinc were monitored at two outflow stations (O-6 and O-7) on a limited basis. The median trace element concentrations detected during this study are tabulated in Table 2.

The outflow monitoring stations, as mentioned earlier, are related to one of two tributaries of the San Joaquin River; those that outflow through Salt Slough (sites O-4 through O-7), and those that outflow through Mud Slough (North), (sites O-1 through O-3) as described in James et al., 1988.

Selenium concentrations at the furthest downstream monitoring station on Salt Slough at Lander Avenue, (O-4), ranged from 1.6 to 27 µg/L with a median of 13 µg/L. Selenium concentrations for the Salt Slough tributary outflow stations (O-5 to O-7) ranged from 4.4 to 49 ug/L with the median values ranging from 14 to 39 ug/L.

Selenium concentrations at Mud Slough (North) at Highway 140 (O-2) ranged from 1.6 to 25 µg/L with a median of 9.3 µg/L. Los Banos Creek flows into Mud Slough (North) downstream of the Highway 140 monitoring station and it has a diluting effect on Mud Slough with respect to selenium as measured at the Newman Land and Cattle Company station (O-1). Los Banos Creek receives its flow from the western portion of the North Grassland Area and from areas west of the study area. The creek receives little subsurface drainage. Selenium concentrations range from 0.4 to 1.7 µg/L with a median of 1.1 µg/L at the Los Banos Creek at Highway 140 station (O-3). The downstream Mud Slough (North) station (O-1) had lower selenium concentrations than site O-2 with values ranging from 1.4 to 18 ug/L and a median of 4.7 ug/L.

## DISCUSSION

The current study shows that water quality within the Grasslands continues to vary widely with the highest constituent concentrations found at the inflow monitoring stations near the southern border of the study area. This inflow water is generally a blend of subsurface tile drainage and surface runoff (tailwater) or operational spills from irrigation canals. Four of these inflow points (I-1, I-2, I-6, and I-8) carry a substantial portion of subsurface drainage water. The highest concentrations at these four sites likely reflect a greater proportion of tile drainage in the flow and not necessarily the quality of subsurface drainage being discharged at the tile drainage sumps. The sites inflowing from the south and southeast continue to carry the highest concentrations of salts, boron, and selenium. Other inflows contain little selenium, however elevated levels of salt and boron are present. For example, the median values for selenium at the four major southern inflow points ranged from 49 to 71 µg/L while other inflow points showed median selenium values ranging from 1.2 to 7.9 µg/L. For boron however, the four drains carrying the high selenium water showed median boron values ranging from 4.5 to 6.4 mg/L while the other inflow drains that have low selenium values showed median boron values ranging from 0.38 to 8.6 mg/L.

Concentration at the internal flow and outflow monitoring stations were comparable to each other and were substantially lower than the southern inflows. The water quality reflects the amount of mixing and dilution that takes place as drainage water moves through the Grassland Area. The flows are strongly regulated by an extensive system of man-made structures and trends in water quality are difficult to identify.

Table 3. Median Constituent Concentrations for Grassland Area Drains During Water Years 85, 86, 87, and 88  
(Data for WY's 85, 86, and 87 from James et al., 1988)

Map ID	Monitoring Site Water Year	umhos/cm EC	Median Constituent Concentrations									
			mg/L			ug/L						
			B	Cl	SO4	Se	Mo	Cr	Cu	Ni	Pb	Zn
I-1	Firebaugh Drain/Russell											
	Dry WY 85	2400	3.2	230	693	35	–	–	–	–	–	–
	Wet WY 86	2700	3.5	250	900	46	14	16	9	27	–	14
	Critical WY 87	2600	3.4	270	630	42	9	19	9	22	–	28
I-2	Panoche Drain/O'Banion											
	Dry WY 85	3500	6.5	460	985	38	3	–	–	–	–	–
	Wet WY 86	3400	5.8	390	800	56	6.1	26	5.5	15	–	15
	Critical WY 87	4375	7.8	550	1075	47	2.5	40	10	13	–	18
I-3	Agatha Inlet Drain											
	Dry WY 85	–	–	–	–	–	–	–	–	–	–	–
	Wet WY 86	3300	7.2	360	1000	14	10	7	5	13	–	10
	Critical WY 87	3125	7.0	302	800	6.0	16	5	3	7	–	3
I-4	Agatha Canal											
	Dry WY 85	2600	4.9	315	1100	26	1	–	–	–	–	–
	Wet WY 86	3300	5.6	400	900	44	<5	13	9	21	–	16
	Critical WY 87	3305	5.6	410	760	38	6	22	7	12	–	12
I-6	Hamburg Drain											
	Dry WY 85	3200	3.8	435	900	47	6	–	–	–	–	–
	Wet WY 86	3250	4.0	400	1000	51	4	13	5	10	–	13
	Critical WY 87	3345	3.7	420	925	58	<5	17	5	8	–	10
I-7	Camp 13 Slough											
	Dry WY 85	2550	3.4	280	745	32	4	–	–	–	–	–
	Wet WY 86	2950	3.9	375	905	43	<5	14	7	20	–	16
	Critical WY 87	2650	3.7	280	590	43	6	30	11	13	–	19
I-8	Charleston Drain											
	Dry WY 85	3900	2.6	395	1275	48	–	–	–	–	–	–
	Wet WY 86	4500	4.7	510	1580	93	7.9	9	10	14	–	18
	Critical WY 87	3855	4.2	480	1035	79	2	32	12	22	–	50
I-9	Almond Drive Drain											
	Dry WY 85	1520	1.6	160	340	2.0	–	–	–	–	–	–
	Wet WY 86	–	–	–	–	–	–	–	–	–	–	–
	Critical WY 87	1925	2.1	224	395	4.8	4.5	28	11	21	–	25
I-10	Rice Drain											
	Dry WY 85	2450	5.7	245	715	2.5	–	–	–	–	–	–
	Wet WY 86	3300	8.1	350	1080	3.0	14	5	6	23	–	13
	Critical WY 87	2500	6.1	260	550	2.6	11	3	3	6	–	<1
I-11	Boundary Drain											
	Dry WY 85	1090	0.45	195	135	1.0	–	–	–	–	–	–
	Wet WY 86	1710	0.65	250	210	1.0	6	2	7	9	–	14
	Critical WY 87	1250	0.54	200	145	1.6	4	<1	2	<5	–	3
	Critical WY 88	1470	0.50	230	180	1.4	6	–	–	–	–	–

Table 3 continued:

Map ID	Monitoring Site	Water Year	umhos/cm EC	Median Constituent Concentrations									
				mg/L			ug/L						
				B	Cl	SO4	Se	Mo	Cr	Cu	Ni	Pb	Zn
I-12	Salt Slough/Hereford	Dry WY 85	850	0.37	120	100	1.0	-	-	-	-	-	-
		Wet WY 86	785	0.33	100	99	1.0	<5	3	5	9	-	22
		Critical WY 87	1000	0.39	130	120	1.4	3	1	2	<5	-	2
		Critical WY 88	1150	0.38	160	140	1.2	5	-	-	-	-	-
T-1	CCID Main Canal/Russell	Dry WY 85	430	0.21	72	35	<1	-	-	-	-	-	-
		Wet WY 86	385	0.21	53	47	1.3	<5	3	3	5	-	8
		Critical WY 87	570	0.28	65	58	2.2	<5	1	3	<5	-	3
		Critical WY 88	760	0.29	120	65	1.7	-	-	-	-	-	-
T-7	San Luis Canal/HWY 152	Dry WY 85	1550	1.4	180	295	4.5	-	-	-	-	-	-
		Wet WY 86	1200	1.4	130	200	2.0	<5	4	4	10	-	9
		Critical WY 87	2630	3.4	260	520	4.0	<5	3	3	<5	-	7
		Critical WY 88	2550	3.6	280	570	3.9	-	-	-	-	-	-
O-1	Mud Slough / NGC	Dry WY 85	-	-	-	-	-	-	-	-	-	-	-
		Wet WY 86	1800	2.0	215	330	4.0	5	9	5	11	-	15
		Critical WY 87	2600	2.4	300	420	5.1	13	7	4	10	-	1
		Critical WY 88	2480	2.2	330	440	4.7	-	-	-	-	-	-
O-2	Mud Slough/HWY 140	Dry WY 85	2600	3.1	305	525	13	-	-	-	-	-	-
		Wet WY 86	2300	3.0	280	630	8.5	8	6	5	14	-	11
		Critical WY 87	2600	3.0	320	540	17	8.5	12	9	11	-	7
		Critical WY 88	2820	2.7	350	510	9.3	11	-	-	-	-	-
O-3	Los Banos Creek/HWY 140	Dry WY 85	-	-	-	-	-	-	-	-	-	-	-
		Wet WY 86	2200	2.3	430	300	1.0	<5	6	8	18	-	17
		Critical WY 87	1855	1.6	215	215	1.4	-	-	-	-	-	-
		Critical WY 88	1690	1.2	230	210	1.1	-	-	-	-	-	-
O-4	Salt Slough/Lander Ave.	Dry WY 85	1250	0.96	185	195	4.5	-	-	-	-	-	-
		Wet WY 86	1610	1.3	240	245	7.4	7	4	6	12	-	18
		Critical WY 87	1720	1.7	250	350	12	6	6	4	6	-	4
		Critical WY 88	1940	1.9	260	385	13	6	-	-	-	-	-
O-5	Salt Slough/Wolfson Road	Dry WY 85	1200	1.1	190	230	6.0	-	-	-	-	-	-
		Wet WY 86	1300	1.3	190	250	7.9	7	6	9	11	-	20
		Critical WY 87	1900	2.0	250	340	15	5	6	5	6	-	6
		Critical WY 88	2200	2.2	280	460	14	-	-	-	-	-	-
O-6	City Ditch	Dry WY 85	2100	3.1	240	540	18	-	-	-	-	-	-
		Wet WY 86	2600	4.1	345	740	27	6	12	9	27	-	29
		Critical WY 87	3110	3.8	300	630	41	11	15	4	11	-	16
		Critical WY 88	3280	4.4	380	810	39	-	18	18	35	<5	52
O-7	Santa Fe Canal/MSD	Dry WY 85	-	-	-	-	-	-	-	-	-	-	-
		Wet WY 86	2550	3.9	315	610	27	11	5	5	11	-	3
		Critical WY 87	2780	3.9	270	640	44	11	13	6	10	-	13
		Critical WY 88	2800	3.9	370	670	38	-	11	5	7	<5	9

Water Years (WY) run from 1 October through 30 September.

Data for this study includes information for Water Year 1988 (WY 88). WY 88 is the second of back to back critical water years. Tabulated in Table 3 are median constituent concentrations by water year for all the study monitoring sites since 1985. Median concentrations were listed for WY 85 where available, however the 1985 data set may be incomplete for some locations. Concentrations for all the drains and sloughs were routinely higher during the critical Water Years 1987 and 1988 than during the wet Water Year 1986. The elevated concentrations may be due in part to increased influence of the shallow groundwater as well as a decrease in dilution from irrigation spill water or tail water runoff. The decrease in irrigation spill water or tail water may be due to more efficient use of limited supply water.

The few exceptions to the general increase in concentrations are the Agatha Canal, Charleston Drain, Rice Drain, Boundary Drain, and Los Banos Creek at Hwy 140. At various times of the year, the Agatha Canal can carry agricultural drainage (subsurface and tail water), supply water (purchase and operational spill), or a mixture of the two. The Rice Drain and Boundary Drain provide inflow to the eastern portion of the study area. Los Banos Creek is a natural stream channel which drains the coastal foothills but carries a substantial portion of tail water and operational spill water. The Charleston Drain carries a substantial percent of subsurface agricultural drainage from the southwest portion of the study area. The lower observed concentrations during the critical water years have not been explained.

The two main outflows, Mud Slough (North) and Salt Slough were monitored during the study. These sites represent water quality of the blended drainage flowing from the Grassland Area to the San Joaquin River. The quality of both sloughs varied widely depending upon which slough was carrying the greatest portion of subsurface tile drainage water. Median concentrations for the two sloughs were similar although a wide range of variability was detected. For example, Salt Slough selenium concentrations ranged from 1.6 to 27  $\mu\text{g/L}$  with a median of 13  $\mu\text{g/L}$ . Mud Slough showed a similar variability with a median selenium value of 9.3  $\mu\text{g/L}$ . During wet WY 86, the median boron concentration at Salt Slough at Lander Avenue was 1.3 mg/L. During the drier years, WY 87 and WY 88, median concentrations increased to 1.7 mg/L and 1.9 mg/L, respectively. Although median boron concentrations did not increase directly for Mud Slough at Hwy 140, peak monthly concentrations were higher on a number of occasions.

Selenium followed a similar trend in Salt and Mud Sloughs. Median values in Salt Slough increased from 7.4  $\mu\text{g/L}$ , 12  $\mu\text{g/L}$ , to 13  $\mu\text{g/L}$  for WY 86, WY 87, and WY 88, respectively. Selenium values in Mud Slough (North) also showed an increasing trend although the highest median concentration peaked in WY 87 at 17  $\mu\text{g/L}$ . WY 86 and WY 88 showed 8.5  $\mu\text{g/L}$  and 9.3  $\mu\text{g/L}$  median selenium concentrations in Mud Slough (North).

Figures 3 through 6 present boron and selenium concentrations for Mud and Salt Sloughs by Water Year. As can be seen in all four figures, the time of year patterns remain the same regardless of water year type. As shown in James et al., 1988, the concentrations tend to increase during the non-irrigation period (October to March) and decrease during the irrigation period (April to September). During the non-irrigation period, flows in the drains and canals consist mainly of shallow groundwater seepage and subsurface drainage. These two water types have been shown to contain elevated levels of a number of constituents including boron and selenium (Lowry et al., 1989; Deverel et al., 1984; and Chilcott et al., 1988). During the irrigation season, a large proportion of the flow in the Grassland Area drains consists of surface agricultural runoff (tail water) which dilutes the subsurface agricultural drainage, thus lowering the boron and selenium concentrations. During the non-irrigation season, there is no surface runoff, so the drains carry a higher proportion of subsurface agricultural drainage, and consequently, boron and selenium values are higher.

Figure 3. Boron Concentrations in Salt Slough  
@ Lander Ave. for Water Years 86, 87, 88

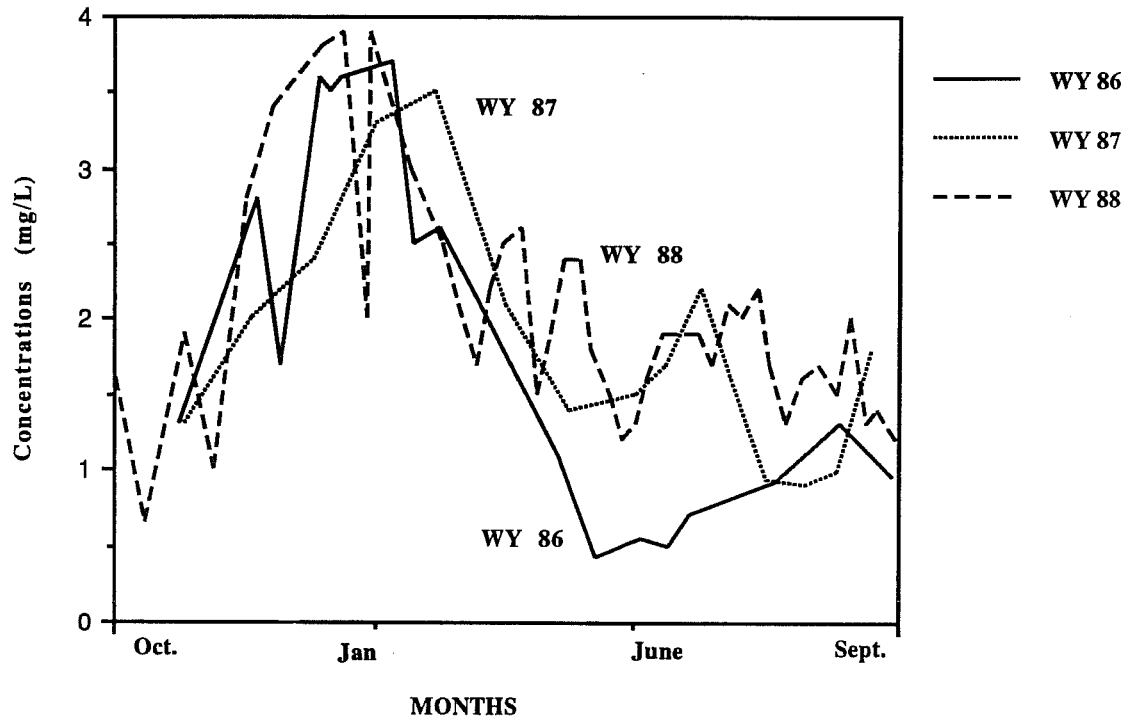


Figure 4. Selenium Concentrations in Salt Slough  
@ Lander Ave. for Water Years 86, 87, 88

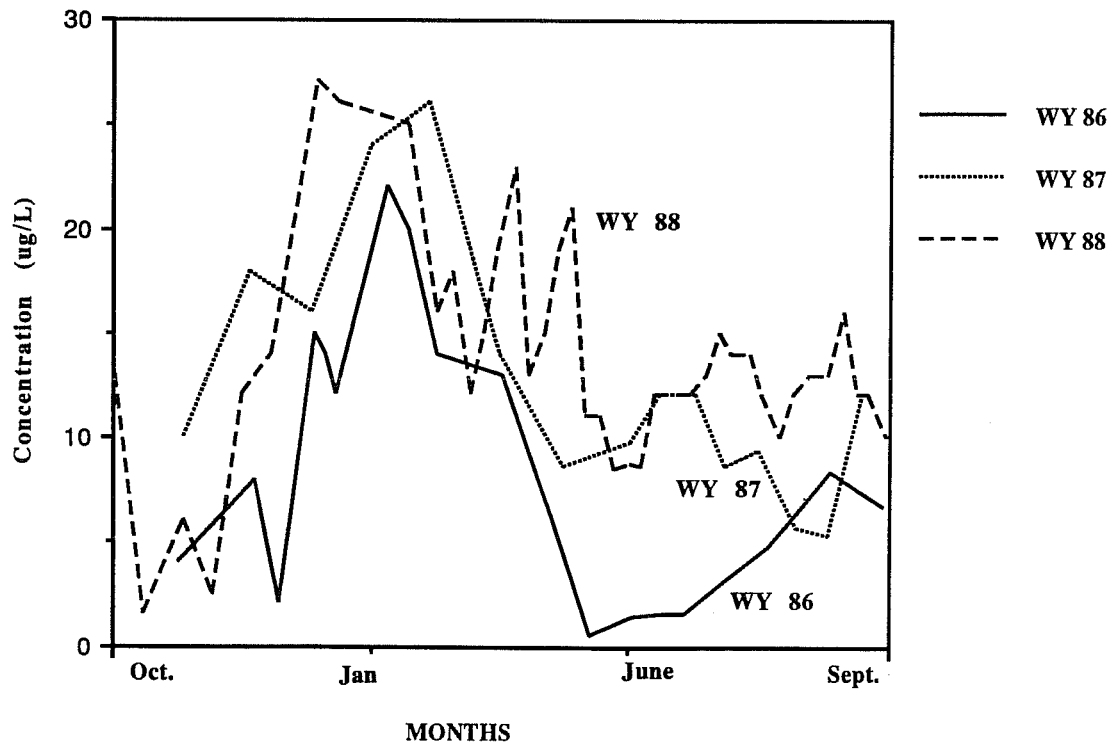


Figure 5. Boron Concentrations in Mud Slough (North) @ Hwy. 140 for Water Years 86, 87, 88

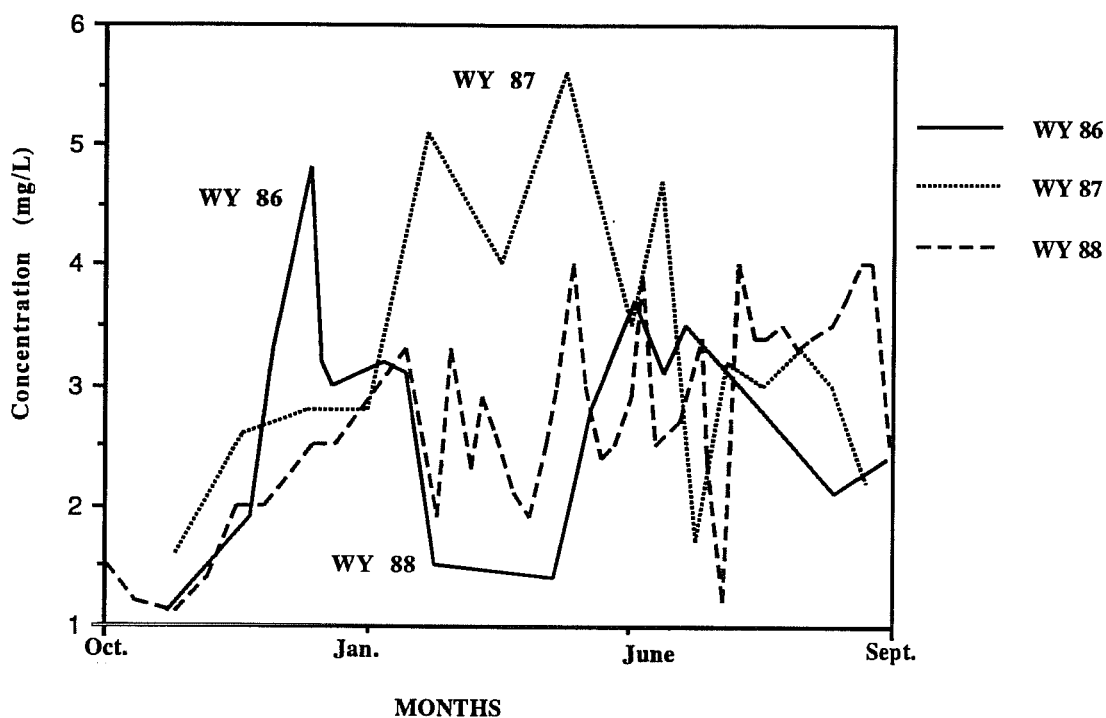
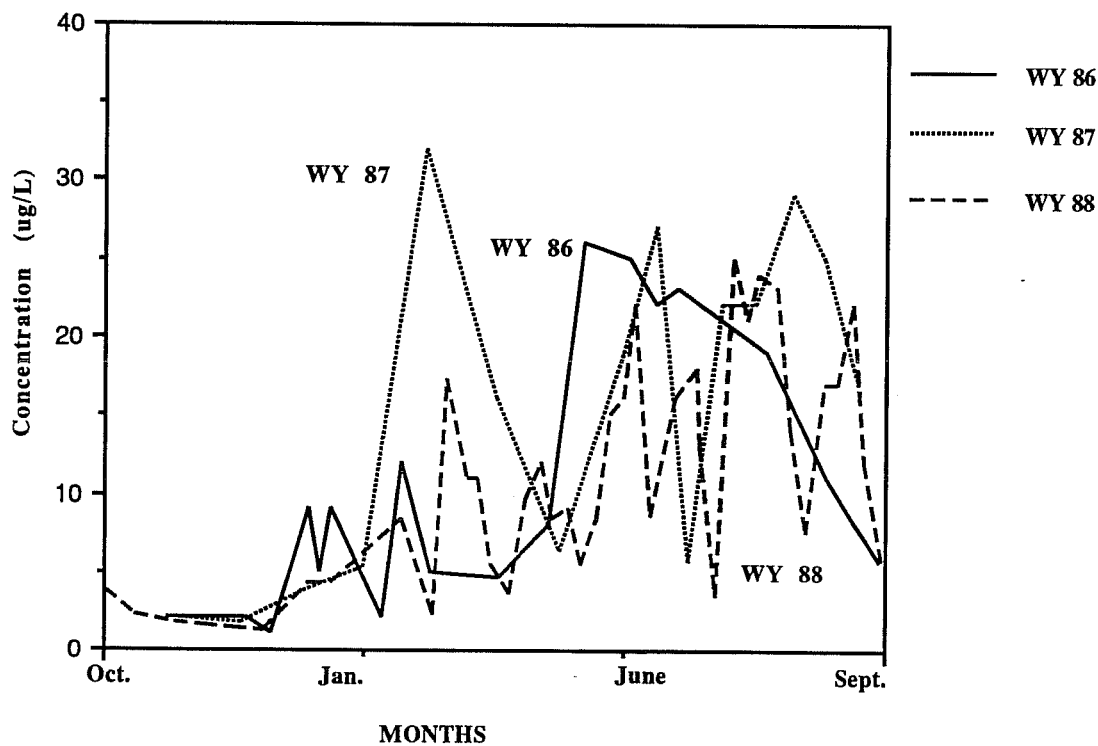


Figure 6. Selenium Concentrations in Mud Slough (North) @ Hwy. 140 for Water Years 86, 87, 88



Chromium was found to be an element of concern during this study. Chromium is commonly found in shallow water in the western San Joaquin Valley south of the study area, especially in water derived from alluvial fan deposits (Deverel et al., 1984, and Chilcott et al., 1988). The highest chromium concentrations found in this monitoring program occurred in the Panoche Drain which receives its flow from areas with alluvial fan deposits. Ambient water quality criteria for chromium is based on concentrations of hexavalent chromium species. This monitoring program measured total recoverable chromium, therefore the current reported data can not be directly compared to the criteria. However, during WY 88, median values of total recoverable chromium routinely exceeded the four day average ambient water quality criteria of 11 ug/L for the protection of freshwater aquatic life. Five of the eight drains monitored had median chromium concentrations exceeding 16 ug/L, the one hour average criteria for protection of aquatic life (EPA, 1985). All the criteria values for the protection of freshwater aquatic life are based on acid soluble metals, whereas the trace element results in this study are total recoverable concentrations. For a given sample, the total recoverable concentrations are generally higher than acid soluble concentrations (Marshack, personal communication).

Since chromium is closely associated with the sediment, the monitoring program has been altered to analyze dissolved chromium as well as total recoverable chromium in downstream stations along the San Joaquin River. Analysis for acid soluble hexavalent chromium would be needed to evaluate the impact of chromium on the quality of water in these drains. A study plan for a survey of hexavalent chromium at and upstream of inflow monitoring stations (areas where total chromium concentration appear the highest) is currently under review by Regional Board staff.

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## APPENDIX A

### Mineral and Trace Element Water Quality Data for Inflow Monitoring Stations Listed in Order by Map Index Number

Map Index	RWQCB Site I.D.	Site Name	Page
I-1	MER556	Firebaugh @ Russell Avenue	19
I-2	MER501	Panoche Drain	20
I-3	MER552	Agatha Inlet (Mercy Springs) Drain	21
I-4	MER506	Agatha Canal	22
I-6	MER504	Hamburg Drain	23
I-7	MER505	Camp 13 Slough	24
I-8	MER502	Charleston Drain	25
I-9	MER555	Almond Drive Drain	26
I-10	MER509	Rice Drain	27
I-11	MER521	Boundary Drain	28
I-12	MER528	Salt Slough Ditch @ Hereford Road	29



Map Index I-1 .....Firebaugh Drain at Russell Avenue (MER556)

Location .....Latitude 36 55'27", Longitude 120 39'11". In SW 1/4, SW 1/4, SW 1/4, Sec. 34, T.11S.,  
R.12E. E side of Russell Ave., 2.7 mi. S of South Dos Palos.

Date	Time	pH	EC umhos/cm	Se	Mo	Cu	Cr	Ni	Pb	Zn	B	Cl	SO4	CO3	HCO3	Total	
																Alk.	Temp
							ug/L								mg/L		
10/01/87	0945	7.6	2760	50	13	8	18	18	7	23	3.3	300	660			130	69
11/03/87	1510	7.8	3600	47	12	14	28	32	<5	41	3.8	420	1100	0	170	170	59
12/01/87	1600	8.6	7510	187	52	3	5	6	<5	3	9.2	840	2500	6	130	136	56
01/05/88	1050	6.9	6350	150	36	5	8	10	<5	21	6.1	750	1500	0	380	380	50
01/27/88	1440	7.9	3100	55		7	10	10	<5	17	3.3	270	780	0	140	140	53
03/09/88	1530		4500	119		10	20	19	<5	24	7.0	450	1500	<1	160	160	61
03/30/88	1600	8.0	2700	45	7	14	25	25	<10	36	3.0	270	740	<1	130	130	58
05/05/88	1915	8.0	3850	64	17	12	27	22	<5	27	4.3	380	1200	<1	140	140	58
06/01/88	1620	7.6	2350	36	8	13	20	22	<5	32	2.5	240	590	<1	160	160	70
06/29/88		7.8	2900	44	13	11	23	23	<5	31	3.7	280	790				70
08/01/88		7.9	2450	36	5	15	30	35	5	49	2.5	260	560	<1	150	150	80
09/01/88	1640		2860	48	8	12	28	32	6	35	3.5	340	730	<1	160	160	80
=====																	
WY 88	Min	6.9	2350	36	5	3	5	6	<5	3	2.5	240	560	0	130	130	50
	Med	7.9	3000	49	10	12	22	22	<5	29	3.6	320	790	<1	160	150	60
	Max	8.6	7510	187	52	15	30	35	7	49	9.2	840	2500	6	380	380	80
	Count	10	12	12	10	12	12	12	12	12	12	12	12	10	10	11	12
-----																	

Map Index I-2 .....Panoche Drain at O'Banion Gauge Station (MER501)

Location .....Latitude 36 55'27", Longitude 120 41'19". In SW 1/4, SW 1/4, SW 1/4, Sec. 32, T.11S., R.12E.  
 Located 0.5 mi. S of CCID Main Canal, 1.9 mi. W of Russell Rd., 5.5 mi. SW of Dos Palos,  
 3.4 SW of South Dos Palos.

Date	Time	pH	EC umhos/cm	Se	Mo	Cu	Cr	Ni	Pb	Zn	B	Cl	SO4	CO3	HCO3	Total	
																Alk.	Temp
10/01/87	1000	7.8	4750	69	7	5	34	14	<5	17	8.7	670	1150			200	68
11/03/87	1525	8.2	4550	42	3	16	68	43	6	48	8.8	680	1500	0	190	190	63
12/01/87	1540	7.9	3460	55	4	12	35	14	<5	23	5.2	430	820	0	140	140	59
01/27/88	1500	8.0	5300	109		5	46	8	<5	11	8.5	600	1300	0	190	190	60
03/09/88	1540		4200	60		17	73	27	6	38	7.1	500	1000	<1	170	170	60
03/30/88	1525	8.1	3650	59	2	20	66	29	11	45	6.4	430	890	<1	160	160	60
05/05/88	1830	7.8	4250	54	5	7	39	11	<5	12	7.4	490	1100	<1	170	170	60
06/01/88	1605	7.9	3150	44	3	17	43	26	<5	38	5.2	380	740	<1	200	200	76
06/29/88		8.0	3400	46	2	13	44	21	<5	29	5.6	410	790				69
08/01/88		7.9	2900	34	3	6	25	15	<5	20	3.9	350	630	<1	150	150	79
09/01/88	1625		3380	49	4	10	29	26	<5	29	4.9	440	770	<1	180	180	84
=====																	
WY 88	Min	7.8	2900	34	2	5	25	8	<5	11	3.9	350	630	0	140	140	59
	Med	7.9	3650	54	3	12	43	21	<5	29	6.4	440	890	<1	170	180	63
	Max	8.2	5300	109	7	20	73	43	11	48	8.8	680	1500	<1	200	200	84
	Count	9	11	11	9	11	11	11	11	11	11	11	11	9	9	10	11
-----																	

Map Index I-3 .....Mercy Springs Drain (Outlet) near Panoche Drain (MER552) ,

Location .....Latitude 36 56'01", Longitude 120 42'05". In SE 1/4, SE 1/4, NW 1/4, Sec. 31, T.11S., R.12E.  
S of Firebaugh Drain, 2.6 mi. W of Russell Ave., 2.8 mi. S of South Dos Palos.

Date	Time	pH	EC umhos/cm	Se	Mo	Cu	Cr	Ni	Pb	Zn	B	Cl	SO4	CO3	HCO3	Alk.	Temp
														Total .....mg/L.....			
10/01/87	1015	8.2	4760	14	31	6	12	24	<5	12	5.0	550	1300			200	70
11/03/87	1540	8.7	7800	13	47	4	10	14	<5	13	20	960	3000	0	220	220	60
03/09/88	1555		5750	4.5							14	590	1900	4	190	194	60
03/30/88	1535	8.2	2150	6.5		11	19	18	<10	19	4.9	220	560	<1	130	130	62
05/05/88	1850	8.2	4150	7.9							7.9	470	1300	<1	180	180	61
06/01/88	1545	8.1	3800	9.2		5	6	10	<5	6	8.6	470	1100	<1	150	150	80
06/29/88		7.9	4100	7.5							9.1	470	1100				74
08/01/88		8.1	5200	10		5	10	15	<5	12	12	600	1400	<1	260	260	86
09/01/88	1610		3810	7.4							7.9	540	980	<1	200	200	80
=====																	
WY 88	Min	7.9	2150	4.5	31	4	6	10	<5	6	4.9	220	560	0	130	130	60
	Med	8.2	4150	7.9	39	5	10	15	<5	12	8.6	540	1300	<1	190	200	70
	Max	8.7	7800	14	47	11	19	24	<10	19	20	960	3000	4	260	260	86
	Count	7	9	9	2	5	5	5	5	5	9	9	9	7	7	8	9
-----																	

Map Index I-4 .....Agatha Canal at Helm Canal (MER506)

Location .....Latitude 36 56'04", Longitude 120 41'06". In NE 1/4, SE 1/4, NW 1/4,  
Sec. 31, T.11S., R.12E. 150 ft. N of Helm Canal, 2.6 mi. W of  
Russell Ave., 3.4 mi. SW of South Dos Palos.

Date	Time	pH	EC umhos/cm	Se ...ug/L...	Mo	B	Cl	SO4	CO3	HCO3	Total Alk.	Temp
10/01/87	0920	8.0	786	2.2	1	0.4	120	66			88	71
11/03/87	1450	7.8	3650	41	4	5.6	480	1000	0	170	170	63
01/27/88	1410	8.5	8100	16		20	830	2600	6	170	176	54
03/09/88	1505		5250	6.3		13	530	1800	<1	190	190	61
03/30/88	1505	8.0	3450	67		5.5	380	860	<1	160	160	59
05/05/88	1815	8.1	4250	66		6.7	490	1200	<1	170	170	60
06/01/88	1515	7.9	2800	40		3.8	320	690	<1	150	150	74
06/29/88		8.0	3300	37		5.3	360	820				71
08/01/88		8.0	2950	45		3.7	340	700	<1	160	160	80
09/01/88	1550		3730	21		6.9	510	930	<1	200	200	82
=====												
WY 88	Min	7.8	786	2.2	1	0.40	120	66	0	150	88	54
	Med	8.0	3550	39	2.5	5.6	430	895	<1	170	170	67
	Max	8.5	8100	67	4	20	830	2600	6	200	200	82
	Count	8	10	10	2	10	10	10	8	8	9	10
-----												

Map Index I-6 .....Hamburg Drain near Camp 13 Slough (MER504)

Location .....Latitude 36 56'32", Longitude 120 45'23". In SE 1/4, SE 1/4, SW 1/4, Sec. 27, T.11S., R.11E.  
50 ft. S of CCID main Canal, 9.2 mi. S-SE of Los Banos, 6.7 mi. W-SW of South Dos Palos.

Date	Time	pH	EC umhos/cm	Se	Mo	Cu	Cr	Ni	Pb	Zn	B	Cl	SO4	CO3	HCO3	Total	
																Alk.	Temp
.....ug/L.....mg/L.....																	
10/01/87	0910	7.9	3650	56	4	6	12	<5	<5	6	4.4	480	900			130	66
11/03/87	No Flow																
12/01/87	No Flow																
01/27/88	1355	8.1	3500	56		2	10	<5	<5	6	3.1	410	860	0	110	110	58
03/09/88	1450		4400	71		14	46	22	5	36	5.1	530	1300	<1	150	150	62
03/30/88	1445	8.0	4850	76	2	9	34	17	<10	19	7.4	580	1400	<1	100	100	63
06/01/88	No Flow																
06/29/88		8.8	3500	29	5	1	8	<5	<5	<1	3.8	360	1100	8	70	78	84
08/01/88		9.6	3250	21	6	3	4	<5	<5	3	2.9	320	1000	<1	40	40	97
09/01/88	No Flow																
=====																	
WY 88	Min	7.9	3250	21	2	1	4	<5	<5	<1	2.9	320	860	0	40	40	58
	Med	8.1	3600	56	4.5	5	11	<5	<5	6	4.1	450	1050	<1	100	110	65
	Max	9.6	4850	76	6	14	46	22	5	36	7.4	580	1400	8	150	150	97
	Count	5	6	6	4	6	6	6	6	6	6	6	6	5	5	6	6
-----																	

Map Index I-7.....Camp 13 Slough at Gauge Station (MER505)

Location .....Latitude 36 56'04", Longitude 120 41'06". In SE 1/4, SE 1/4, SW 1/4,  
Sec. 27, T.11S., R. 11E. 150 ft. N of CCID Main Canal, 6.4 mi. W of  
Russell Ave., 9.2 mi. SE of Los Banos, 6.7 mi. SW of South Dos Palos.

Date	Time	pH	EC umhos/cm	Se ...ug/L...	Mo	B	Cl	SO4	CO3	HCO3	Total	Temp
											Alk.	
10/01/87	0855	7.8	3280	46	10	5.3	380	720			150	72
11/03/87	1430	8.0	4900	4.5	5	8.0	910	1200	0	190	190	61
12/01/87	1525	8.0	1200	9.1	2	0.7	170	190	0	90	90	54
01/27/88	1345	7.7	4250	79		5.6	480	1100	0	160	160	56
03/09/88	1435		4550	92		7.1	520	1300	<1	170	170	62
03/30/88	1435	8.0	4900	74	3	6.7	560	1350	<1	160	160	61
05/05/88	1740	7.9	6700	107	5	8.6	870	1800	<1	110	110	63
06/29/88		8.4	4900	7.9	3	8.3	800	1000				78
08/01/88		8.1	2150	3.1	3	2.5	260	450	<1	140	140	83
09/01/88	1530		3190	40	4	4.3	430	770	<1	170	170	82
=====												
WY 88	Min	7.7	1200	3.1	2	0.67	170	190	0	90	90	54
	Med	8	4400	43	3.5	6.2	500	1050	<1	160	160	63
	Max	8.4	6700	107	10	8.6	910	1800	<1	190	190	83
	Count	8	10	10	8	10	10	10	8	8	9	10
-----												

Map Index I-8 .....Charleston Drain at CCID Main Canal (MER502)

Location .....Latitude 36 56'59", Longitude 121 46'55". In NE 1/4, SE 1/4, NE 1/4, Sec. 29, T.11S., R.11E.  
N side of CCID Main Canal, 8.7 mi. S-SE of Los Banos, 7.9 mi. W-SW of South Dos Palos.

Date	Time	pH	EC umhos/cm	Se	Mo	Cu	Cr	Ni	Pb	Zn	Total						Temp
											B	Cl	SO4	CO3	HCO3	Alk.	
												.....mg/L.....					
10/01/87	0835	7.3	2730	31	7	3	5	5	<5	8	2.4	320	660			130	64
11/03/87	1420	8.1	4550	63	4	13	28	21	<5	45	4.7	59	1700	0	150	150	64
12/01/87	1510	7.3	10220	28	11	1	2	29	<5	32	24	1600	2700	0	360	360	58
01/27/88	1330	7.5	5600	85		5	15	8	<5	19	4.5	680	1600	0	150	150	59
03/09/88	1425		4200	88		17	37	27	8	58	3.3	500	1200	<1	150	150	62
03/30/88	1420	7.8	4400	96	2	22	57	38	<10	82	4.1	500	1300	<1	160	160	63
05/05/88	1735	7.5	5000	93	3	24	72	40	11	98	4.0	560	1600	<1	140	140	63
06/01/88	1450	7.8	4300	86	3	20	40	35	7	67	3.5	520	1300	<1	310	310	76
06/29/88		7.8	4100	65	2	13	31	24	<5	47	4.0	480	1100	<1	140	140	70
08/01/88		7.9	4450	68	<1	44	82	72	22	170	4.6	540	1100	<1	150	150	79
09/01/88	1515		5200	71	5	5	23	8	<5	16	5.7	690	1500	<1	150	150	80
=====																	
WY 88	Min	7.3	2730	28	<1	1	2	5	<5	8	2.4	59	660	0	140	130	58
	Med	7.8	4450	71	3	13	31	27	<5	47	4.5	520	1300	<1	150	150	64
	Max	8.1	10220	96	11	44	82	72	22	170	24	1600	2700	<1	360	360	80
	Count	9	11	11	9	11	11	11	11	11	11	11	11	10	10	11	11
-----																	

Map Index I-9 .....Almond Drive Drain (MER555)

Location .....Latitude 36 59'55", Longitude 120 49'00". In SW 1/4, SW 1/4, SW 1/4, Sec. 6, T.11S.,  
R.11E. N side of Almond Dr., 1.1 mi. E of Mercy Springs Drain, 100 ft. E of CCID  
Main Canal, 4.7 mi. S of Los Banos.

Date	Time	pH	EC	Se	Cu	Cr	Ni	Pb	Zn	B	Cl	SO4	CO3	HCO3	Total	
															Alk.	Temp
			umhos/cm				ug/L									
10/01/87	0815	7.0	739	1.4	7	16	14	<5	23	0.2	130	47			89	70
11/03/87	1400	8.8	1050	1.3	2	4	<5	<5	4	0.5	170	130	0	110	110	62
12/01/87	1450	8.1	1720	17	1	3	<5	<5	<1	1.2	200	310	0	94	94	57
01/05/88	0940	8.0	2850	4.8						3.2	260	600	0	330	330	56
01/27/88	1305	7.2	2400	3.4	10	28	15	<5	24	2.4	240	480	0	290	290	61
03/09/88	1410		2000	4.6						2.0	200	460	<1	220	220	63
03/30/88	1400	8.1	2500	5.6	8	26	13	<10	15	2.7	250	550	<1	300	300	65
05/05/88	1635	7.7	2350	5.7						2.4	230	530	<1	280	280	65
06/01/88	1430	7.9	2950	6.8	5	18	9	<5	11	3.1	320	690	<1	140	140	75
06/29/88		7.8	2300	4.4						2.1	240	460	<1	250	250	72
08/01/88		7.9	1800	3.4	12	22	21	<5	26	1.6	200	350	<1	170	170	81
=====																
WY 88	Min	7.0	739	1.3	1	3	<5	<5	<1	0.22	130	47	0	94	89	56
	Med	7.9	2300	4.6	7	18	13	<5	15	2.1	230	460	<1	240	220	65
	Max	8.8	2950	17	12	28	21	<10	26	3.2	320	690	<1	330	330	81
	Count	10	11	11	7	7	7	7	7	11	11	11	10	10	11	11
-----																

Map Index I-10 .....Rice Drain at Mallard Road (MER509)

Location .....Latitude 36 59'22", Longitude 120 14'42". In NE 1/4, NW 1/4, SW 1/4, Sec. 7, T.11S., R.11E.  
South of Sante Fe Grade at Brito, 50 ft. W of Mallard Rd., 4.5 mi. W of Dos Palos.

Date	Time	pH	EC umhos/cm	Se	Mo	Cu	Cr	Ni	Pb	Zn	Total						Temp
											B	Cl	SO4	CO3	HCO3	Alk.	
.....mg/L.....																	
10/01/87	1035	8.0	3190	2.9	19						7.3	380	880			170	70
11/03/87	1605	8.1	3000	2.1	19						6.4	380	1000	0	210	210	61
12/01/87	1620	7.7	2680	2.4	12						4.9	290	660	0	200	200	53
01/05/88	1125	7.9	4500	2.4	23						8.8	440	1200	0	250	250	52
01/27/88	1545	8.1	3050	2.1							5.3	350	740	0	220	220	53
03/09/88	1615		3350	2.7							7.4	350	1100	<1	190	190	62
03/30/88	1615	8.1	1700	2.9	6						2.9	200	430	<1	130	130	60
05/05/88	1930	7.5	2900	4.2	19						6.6	290	920	<1	160	160	60
06/01/88	1640	7.6	2200	3.0	15						4.6	240	550	<1	150	150	72
06/29/88		7.8	2600	3.4	14						4.8	300	640				72
08/01/88		7.7	2300	2.4	12	6	10	14	<5	15	3.9	240	500	<1	160	160	81
09/01/88	1710		2350	1.8	6						3.7	310	480	<1	210	210	80
=====																	
WY 88	Min	7.5	1700	1.8	6						2.9	200	430	0	130	130	52
	Med	7.9	2790	2.6	15						5.1	310	700	<1	200	190	62
	Max	8.1	4500	4.2	23						8.8	440	1200	<1	250	250	81
	Count	10	12	12	10							12	12	12	10	10	11
-----																	

Map Index I-11 .....Boundary Drain at Department of Fish and Game Pump (MER521)

Location .....Latitude 37 06'32", Longitude 120 46'45". In NE 1/4, SE 1/4, NE 1/4,  
Sec. 32, T. 9S., R. 11E. North of Henry Miller Rd., 4.6 mi. NE of  
Los Banos.

Date	Time	ph	EC umhos/cm	Se ....ug/L....	Mo	B	Cl	SO4	CO3	HC03	Total Alk.	Temp
10/01/87	1125	7.4	1470	1.5	4	0.48	230	150			140	72
11/03/87	1315	8.0	1500	0.5	6	0.65	260	190	0	120	120	61
12/01/87	1410	7.3	3270	1.2	12	1.4	530	470	0	180	180	59
01/27/88	1635	7.5	2700	0.5		0.87	440	290	0	290	290	59
03/09/88	1325		1650	1.9		0.60	220	240	<1	150	150	60
03/30/88	1310	7.6	1850	1.8		0.68	280	270	<1	150	150	59
05/05/88	1545	7.6	1350	1.9		0.50	180	180	<1	120	120	62
06/01/88	1335	7.5	1300	1.4		0.50	190	160	<1	130	130	74
06/29/88		7.5	1250	1.5		0.40	180	150	<1	110	110	69
08/01/88		7.8	1150	1.1		0.33	180	110	<1	110	110	80
09/01/88	1415		1370	1.4		0.39	230	160	<1	120	120	83
=====												
WY 88	Min	7.3	1150	0.5	4	0.33	180	110	0	110	110	59
	Med	7.5	1470	1.4	6	0.50	230	180	<1	130	130	62
	Max	8.0	3270	1.9	12	1.4	530	470	<1	290	290	83
	Count	9	11	11	3	11	11	11	10	10	11	11
-----												

Map Index I-12 .....Salt Slough Ditch at Hereford Road (MER528)

Location .....Latitude 37 08'30", Longitude 120 45'17". In NW 1/4, NE 1/4, NW 1/4,  
Sec. 22, T. 9S. R. 11E. 3.0 mi. N on Hereford Rd from Henry Miller Rd.

Date	Time	ph	EC umhos/cm	Se ...ug/L...	Mo	B	Cl	SO4	CO3	Total		Temp
										HCO3	Alk	
10/01/87	1140	7.6	1050	1.1	3	0.30	170	100			130	74
11/03/87	1300	8.2	1150	0.6	4	0.35	190	140	0	150	150	58
12/01/87	1425	7.8	1620	0.6	7	0.48	200	210	0	200	200	56
01/05/88	1230	7.9	1950	1.1	6	0.43	220	220	0	290	290	53
01/27/88	1655	7.5	1800	0.4		0.26	290	180	0	210	210	58
03/09/88	1310		1150	1.7		0.30	150	140	<1	150	150	60
03/30/88	1255	7.9	1150	2.0		0.32	150	140	<1	160	160	58
05/05/88	1525	7.7	1150	2.0		0.40	150	150	<1	140	140	60
06/01/88	1315	7.6	950	1.8		0.40	130	120	<1	130	130	72
06/29/88		7.7	1050	1.0		0.40	140	120	<1	130	130	67
08/01/88		8.3	900	1.2		0.26	140	80	<1	90	90	87
09/01/88	1350		1130	1.4		0.42	180	130	<1	140	140	82
=====												
WY 88	Min	7.5	900	0.40	3	0.26	130	80	0	90	90	53
	Med	7.8	1150	1.2	5	0.38	160	140	<1	150	150	60
	Max	8.3	1950	2.0	7	0.48	290	220	<1	290	290	87
	Count	10	12	12	4	12	12	12	11	11	12	12
-----												



## APPENDIX B

### Mineral and Trace Element Water Quality Data for Internal Flow Monitoring Stations Listed in Order by Map Index Number

Map Index	RWQCB Site I.D.	Site Name	Page
T-1	MER510	CCID Main @ Russell Avenue	31
T-7	MER527	San Luis Canal @ HWY 152	32



Map Index T-1 .....CCID Main Canal at Russell Avenue (MER510)

Location .....Latitude 36 55'28", Longitude 120 37'30". In SE 1/4, SE 1/4,  
SE 1/4, Sec. 33, T. 11S., R. 12E. 2.7 mi. S of Dos Palos.

Date	Time	ph	EC	Se	B	Cl	SO4	CO3	HCO3	Total	Temp
										Alk.	
10/01/87	0935	7.9	719	1.0	0.21	120	48			86	71
11/03/87	1500	8.1	760	0.8	0.28	140	60	0	70	70	63
12/01/87	1555	8.3	810	2.1	0.25	140	69	0	86	86	53
01/05/88	1030	8.2	1350	3.6	1.2	150	250	0	100	100	50
01/27/88	1435	8.4	750	1.5	0.33	93	79	0	90	90	52
03/09/88	1520		950	3.5	0.60	120	150	<1	110	110	60
03/30/88	1550	8.2	800	1.9	0.30	110	98	<1	96	96	60
05/05/88	1900	8.2	650	2.6	0.40	73	91	<1	90	90	59
06/01/88	1615	8.1	550	1.7	0.20	78	43	<1	66	66	69
06/29/88		8.2	650	1.3	0.30	85	58				72
08/01/88		8.2	700	1.6	0.25	110	53	<1	70	70	82
09/01/88	1655		820	1.6	0.22	160	60	<1	76	76	83
=====											
WY 88	Min	7.9	550	0.8	0.20	73	43	0	66	66	50
	Med	8.2	760	1.7	0.29	120	65	<1	88	86	62
	Max	8.4	1350	3.6	1.2	160	250	<1	110	110	83
	Count	10	12	12	12	12	12	10	10	11	12
-----											

Map Index T-7...MER527

San Luis Canal at HWY 152

Location.....Latitude 36 03'03", Latitude 120 48'10".

In SE 1/4, SW 1/4, SE 1/4 Sec.18, T.10S., R.11E.

N side of HWY 152, 2.5 mi. E of Los Banos.

Date	Time	pH	EC umhos/cm	Se ug/L	B .....mg/L.....	Cl	SO4	CO3	HCO3	T.Alk	Temp F
10/01/87	1055	8.0	959	1.3	0.5	150	100			100	70
11/03/87	1625	8.7	2950	3.0	3.6	340	810	0	300	300	63
12/01/87	1640	7.8	2820	7.9	3.9	300	640	0	280	280	59
01/05/88	1150	7.9	4050	3.9	5.4	390	880	0	460	460	52
01/27/88	1605	8.3	950	2.3	0.6	120	130	0	110	110	52
03/09/88	1635		1900	3.4	2.3	210	420	<1	210	210	60
03/30/88	1630	8.2	2550	4.1	3.8	270	580	<1	300	300	62
05/05/88	1950	7.9	1150	7.2	1.0	130	200	<1	140	140	59
06/01/88	1700	8.1	2750	3.9	4.0	310	590	<1	320	320	76
06/29/88		8.0	2550	3.9	3.5	290	560				70
08/01/88		7.9	1900	3.0	2.1	220	350	<1	200	200	79
09/01/88	1730		3020	4.3	3.9	330	690	58	250	308	82
=====											
WY 88	Min	7.8	950	1.3	0.5	120	100	0	110	100	52
	Med	8.0	2550	3.9	3.6	280	570	<1	265	280	63
	Max	8.7	4050	7.9	5.4	390	880	58	460	460	82
	Count	10	12	12	12	12	12	10	10	11	12

## APPENDIX C

### Mineral and Trace Element Water Quality Data for Outflow Monitoring Stations Listed in Order by Map Index Number

Map Index	RWQCB Site I.D.	Site Name	Page
O-1	MER551	Mud Slough (N) @ Newman Gun Club	34
O-2	MER541	Mud Slough (N) @ Hwy 140	35
O-3	MER554	Los Banos Creek @ Hwy 140	37
O-4	MER531	Salt Slough @ Lander Avenue	38
O-5	MER530	Salt Slough @ Wolfsen Road	40
O-6	MER543	City Ditch	41
O-7	MER548	Santa Fe Canal - Mud Slough Diversion	42



Map Index 0-1 .....Mud Slough at Newman Land and Cattle Company (MER551)

Location .....Latitude 37 18'33", Longitude 120 57'18". In NW 1/4, NW 1/4,  
SW 1/4, Sec. 23, T.7S., R.9E. 1.7 mi. NE of Santa Fe Grade,  
1.2 mi. N of HWY 140, 4.2 mi. NE of Gustine.

Date	Time	pH	EC umhos/cm	Se ug/L	B	Cl	SO4	CO3	HCO3	Total Alk.	Temp
10/01/87	1330	8.0	2210	3.2	2.0	300	420			220	74
11/03/87	1115	8.1	1350	1.4	0.9	230	180	0	200	200	59
12/01/87	1210	7.8	2700	1.6	1.9	350	420	0	280	280	53
01/05/88	1145		3150	4.1	2.2	420	510	0	320	320	49
01/28/88	1445		2550	1.4	2.1	340	360	0	320	320	54
03/09/88	1120		3150	18	3.4	400	710	<1	250	250	60
03/30/88	1125	8.5	2850	4.5	2.8	400	450	<1	380	380	58
05/05/88	1310	8.0	4050	9.2	3.1	520	900	<1	280	280	64
06/01/88	1120	8.0	2250	16	2.7	270	480	<1	180	180	70
06/29/88		8.3	2400	14	2.8	280	490	<1	190	190	68
08/01/88		8.6	2000	8.9	1.8	250	370	<1	190	190	80
09/01/88	1155		2150	4.8	1.7	310	370	<1	250	250	80
=====											
WY 88	Min	7.8	1350	1.4	0.91	230	180	0	180	180	49
	Med	8.1	2480	4.7	2.2	330	440	<1	250	250	62
	Max	8.6	4050	18	3.4	520	900	<1	380	380	80
	Count	8	12	12	12	12	12	11	11	12	12
-----											

Map Index 0-2 .....Mud Slough (North) at HWY 140 (MER541)

Location .....Latitude 37 17'28, Longitude 120 56'34". In NW 1/4, SE 1/4,  
SE 1/4, Sec, 26, T.7S., R.9E. 1.7 mi. NE of the Sante Fe Grade  
HWY 140 intersection.

Date	Time	pH	EC umhos/cm	Se ...ug/L...	Mo	B	CL	SO4	CO3	HCO3	Alk.	Temp
10/01/87	1300	7.9	1850	3.8	18	1.5	260	260			210	75
10/15/87	0945	6.8	1880	2.2	14	1.2	260	320			180	62
11/03/87	1150	8.0	1550	1.7	8	1.1	250	190	0	210	210	59
11/17/87	1120	8.0	1890	1.5	9	1.4	280	260	0	240	240	54
12/01/87	1240	7.7	2840	1.4	14	2.0	370	470	0	280	280	53
12/14/87	1100	8.1	2700	1.2	12	2.0	360	400	0	310	310	39
01/05/88	1220		3250	4.3	15	2.5	450	510	0	320	320	50
01/15/88	1135	7.9	2900	4.3		2.5	390	510	0	320	320	50
01/28/88	1410		2650			2.2	350	360	0	330	330	54
02/16/88	1120	8.4	3450	8.4		3.3	470	710	0	290	290	56
02/24/88		8.2	3200			2.8	410	630	0	260	260	59
03/02/88	1100	8.2	2300	2.2		1.9	300	400	<1	200	200	56
03/09/88	1200		3050	17.2		3.3	410	700	<1	250	250	60
03/18/88		8.8	3300	11	11	2.3	410	570	<1	330	330	62
03/24/88	0945	7.4	2750	11	11	2.9	360	490	<1	290	290	63
03/30/88	1155	8.3	2600	5.4	9	2.6	360	460	<1	300	300	56
04/08/88	1635	8.3	2600	3.6	7	2.1	370	440	<1	240	240	60
04/15/88	1055		2250	9.5	9	1.9	270	390	<1	180	180	59
04/22/88	1120	8.0	2650	12	9	2.5	300	510	0	210	210	61
04/28/88		8.4	3500	8.4	11	3.0	470	740	<1	260	260	68
05/05/88	1355	8.0	5100	9.0	19	4.0	710	1200	<1	280	280	62
05/11/88	1235	8.0	4000	5.5	18	3.0	570	930	<1	240	240	73
05/19/88	1030	8.4	3000	8.3	15	2.4	430	670	<1	180	180	65
05/25/88	1600	8.3	2250	15	12	2.5	270	450	<1	170	170	75
06/01/88	1200	8.0	2350	16	11	2.9	280	510	<1	180	180	70
06/06/88	1230	7.1	2750	22	12	3.9	340	640	<1	190	190	70
06/13/88	1305	8.3	2350	8.5	9	2.5	290	430	4	196	200	78
06/23/88	1055	7.5	2450	16	8	2.7	300	500	<1	170	170	76
06/29/88		8.2	2600	18	9	3.4	300	560	<1	180	180	65
07/06/88	1500	9.0	2270	13	7	2.4	290	450	16	160	176	80
07/13/88	1130	8.8	1700	3.4	4	1.2	250	290	7	160	167	79
07/20/88	1010	8.8	3500	25	11	4.0	610	1100	<1	150	150	79
07/27/88	0950	8.0	2900	21	11	3.4	350	630	<1	160	160	84
08/01/88		8.5	2800	24	10	3.4	350	630	<1	170	170	79
08/09/88		8.3	2750	23	10	3.5	330	630	<1	160	160	78
08/16/88	1105	9.1	2900	14	13	3.3	390	660	<1	100	100	75
08/23/88	0955	7.8	3280	7.6	13	3.4	530	810	<1	130	130	74
09/01/88	1235		3130	17	14	3.5	440	740	<1	160	160	80
09/08/88	1345		3000	17	12	3.7	390	710	<1	130	130	78
09/15/88	1300		3500	22	15	4.0	460	820	<1	110	110	75
09/20/88	1225		3750	12	16	4.0	530	890	<1	150	150	66
09/29/88	1025	7.2	4120	5.5	8	2.5	630	880	<1	190	190	67

Map Index 0-2 .....Mud Slough (North) at HWY 140 (MER541) continued.

Date	Time	pH	EC umhos/cm	Se ...ug/L...	Mo	B	Cl	SO4	CO3	HCO3	Alk.	Temp
=====												
WY 88	Min	6.8	1550	1.2	4	1.1	250	190	0	100	100	39
	Med	8.2	2820	9.3	11	2.7	360	540	<1	193	200	66
	Max	9.1	5100	25	19	4.0	710	1200	16	330	330	84
	Count	34	42	40	36	42	42	42	40	40	42	42
-----												

Map Index 0-3 .....Los Banos Creek at HWY 140 (MER554)

Location .....Latitude 37 16'35", Longitude 120 57'14". In NE 1/4, SW 1/4,  
SW 1/4, Sec. 35, T.7S., R.9E. S side of Hwy 140, 2.9 mi. NE of  
Gustine.

Date	Time	pH	EC	Se	B	Cl	SO4	CO3	HCO3	Total	Temp
										Alk.	
			umhos/cm	ug/L						mg/L	
10/01/87	1315	8.0	2040	0.6	2.9	240	460			130	77
11/03/87	1135	8.0	1100	0.9	0.52	200	77	0	190	190	58
12/01/87	1230	7.7	1480	1.0	0.82	210	130	0	220	220	53
01/05/88	1210		2200	0.4	1.3	420	320	0	260	260	51
01/28/88	1300		1900	1.0	1.3	270	230	0	250	250	55
03/09/88	1140		7450	0.5	6.6	830	2300	<1	480	480	60
03/30/88	1150	8.5	2850	1.7	2.8	420	350	<1	430	430	57
05/05/88	1340	8.2	4500	1.6	3.3	490	1100	<1	490	490	60
06/01/88	1145	8.1	1300	1.5	1.1	160	180	<1	200	200	75
06/29/88		8.2	1350	1.5	0.9	170	160	<1	200	200	65
08/01/88		8.2	1250	1.2	0.76	170	130	<1	180	180	78
09/01/88	1225		1400	1.4	0.88	200	150	<1	210	210	80
=====											
WY 88	Min	7.7	1100	0.4	0.52	160	77	0	180	130	51
	Med	8.2	1690	1.1	1.2	230	210	<1	220	220	60
	Max	8.5	7450	1.7	6.6	830	2300	<1	490	490	80
	Count	8	12	12	12	12	12	11	11	12	12
-----											

Map Index 0-4 .....Salt Slough at Lander Avenue (Hwy 165) (MER531)

Location .....Latitude 37 14'55", Longitude 120 51'04". In NW 1/4, SE 1/4,  
SE 1/4, Sec. 10, T.8S., R.10E. 13.0 mi. N of Los Banos, 5.0 mi.  
S of HWY 140.

Date	Time	pH	EC umhos/cm	Se ...ug/L...	Mo	B	Cl	SO4	CO3	HCO3	Total Alk.	Temp
10/01/87	1220	7.7	1920	13		1.6	260	320			160	74
10/15/87	1025	6.8	1480	1.6	4	0.66	210	190			160	64
11/03/87	1225	8.2	1900	6.0		1.9	260	330	0	170	170	61
11/17/87	1230	7.8	1687	2.4		1.0	270	240	0	170	170	54
12/01/87	1330	7.5	2690	12	10	2.8	350	520	0	220	220	54
12/14/87	1145	7.8	3200	14	13	3.4	450	660	0	240	240	41
01/05/88	1300		3700	27	12	3.8	480	760	0	230	230	51
01/15/88	1045	7.8	3450	26		3.9	480	840	0	230	230	50
01/27/88	1735	7.6				2.0	480	520	0	280	280	52
01/28/88	1330		3600			3.9	440	790	0	220	220	55
02/16/88	1210	8.1	2700	25		3.0	350	630	0	180	180	54
03/02/88	1150	8.2	2050	16		2.5	270	430	<1	150	150	57
03/09/88	1240		2300	18		2.1	290	490	<1	170	170	59
03/18/88		8.8	2100	12	7	1.7	260	390	<1	160	160	60
03/24/88	0840	7.0	2350	15	7	2.2	320	480	<1	180	180	62
03/30/88	1225	7.9	2500	19	7	2.5	330	540	<1	180	180	57
04/08/88	1545	8.0	2550	23	8	2.6	320	520	<1	180	180	62
04/15/88	1140		1600	13	5	1.5	230	310	<1	140	140	60
04/22/88	1030	7.6	2000	15	4	1.9	220	390	0	160	160	58
04/28/88		7.8	2450	19	5	2.4	320	530	<1	160	160	67
05/05/88	1440	7.8	2400	21	7	2.4	290	530	<1	160	160	60
05/11/88	1140	7.6	1700	11	8	1.8	250	400	<1	150	150	66
05/19/88	1110	7.8	1800	11	6	1.5	230	350	<1	160	160	68
05/25/88	1640	7.8	1550	8.5	6	1.2	200	280	<1	150	150	73
06/01/88	1240	7.7	1600	8.7	6	1.3	190	270	<1	140	140	71
06/06/88	1315	7.0	1550	8.6	6	1.6	210	290	<1	140	140	68
06/13/88	1345	7.8		12	6	1.9	200	340	<1	150	150	74
06/23/88	1015	7.1	1850	12	5	1.9	310	390	<1	140	140	74
06/29/88		7.9	1950	12	5	1.9	250	370	<1	170	170	68
07/06/88	1420	8.4	1820	13	5	1.7	240	350	<1	140	140	76
07/13/88	1105	8.0	2050	15	6	2.1	270	420	7	140	147	76
07/20/88	0930	7.8	2000	14	6	2.0	270	380	3	140	143	77
07/27/88	1035	7.8	2200	14	5	2.2	260	410	<1	150	150	82
08/01/88		7.9	1850	12	4	1.7	260	340	<1	140	140	79
08/09/88		8.0	1650	10	4	1.3	220	290	<1	110	110	76
08/16/88	1155	8.2	1700	12	6	1.6	240	320	<1	140	140	72
08/23/88	1025	7.5	1620	13	5	1.7	230	330	<1	140	140	74
09/01/88	1315		1800	13	5	1.5	250	340	<1	140	140	80
09/08/88	1430		2040	16	6	2.0	280	390	14	140	154	77
09/15/88	1345		1750	12	5	1.3	240	300	<1	150	150	72
09/20/88	1155		1650	12	5	1.4	250	300	<1	130	130	65
09/29/88	1100	8.2	1600	10	4	1.2	230	250	<1	150	150	68

Map Index 0-4 .....Salt Slough at Lander Avenue (Hwy 165) (MER531) continued.

Date	Time	pH	EC umhos/cm	Se ...ug/L...	Mo	B	Cl	SO4	CO3	HCO3	Alk.	Temp
=====												
WY 88	Min	6.8	1480	1.6	4	0.66	190	190	0	110	110	41
	Med	7.8	1940	13	6	1.9	260	385	<1	150	157	77
	Max	8.8	3700	27	13	3.9	480	840	14	280	280	82
	Count	34	40	40	33	42	42	42	40	40	42	42
-----												

Map Index 0-5 .....Salt Slough at Wolfsen Road (MER530)

Location .....Latitude 39 09'33", Longitude 120 48'40". In SE 1/4, SW 1/4,  
SW 1/4, Sec. 7, T.9S., R.11E. 0.9 mi. E of Lander Ave. (HWY 165)

Date	Time	pH	EC	Se	B	Cl	SO4	CO3	HCO3	Total	Temp
										Alk	
			umhos/cm	ug/L						mg/L.....	
10/01/87	1200	7.6	1770	11	1.5	260	300			140	73
11/03/87	1245	8.2	1900	4.4	2.0	280	360	0	170	170	61
12/01/87	1345	7.6	2900	14	2.9	390	560	0	210	210	56
01/05/88	1305	7.8	3700	27	3.6	440	760	0	220	220	54
01/27/88	1720	7.8	3650	34	3.9	440	790	0	220	220	52
03/09/88	1255		2350	20	2.3	300	520	<1	170	170	60
03/30/88	1245	7.9	2550	24	2.8	320	570	<1	170	170	60
05/05/88	1455	7.8	2300	18	2.5	270	520	<1	150	150	60
06/01/88	1300	7.6	1500	7.9	1.3	180	270	<1	140	140	72
06/29/88		7.7	1950	13	1.9	240	380	<1	140	140	69
08/01/88		7.9	1800	13	1.6	240	330	<1	150	150	79
09/01/88	1330		2000	14	1.9	280	390	<1	160	160	82
=====											
WY 88	Min	7.6	1500	4.4	1.3	180	270	0	140	140	52
	Med	7.8	2200	14	2.2	280	460	<1	170	170	61
	Max	8.2	3700	34	3.9	440	790	<1	220	220	82
	Count	10	12	12	12	12	12	11	11	12	12
-----											

Map Index 0-6 .....City Ditch (San Luis Wasteway to Mud Slough) (MER543)

Location .....Latitude 37 07'44", Longitude 120 48'53". In SW 1/4, SW 1/4, SW 1/4, Sec. 19, T.9S.,  
R.11E. 2.2 mi. N of Los Banos Wildlife Refuge.

Date	Time	pH	EC umhos/cm	Se	Cu	Cr	Ni	Pb	Zn	B	Cl	SO4	CO3	HCO3	Total	
															Alk.	Temp
03/09/88	1345		3400	43	19	56	35	6	53	4.7	430	930	<1	180	180	61
03/30/88	1330	7.9	3300	41						4.4	380	830	<1	170	170	60
06/01/88	1400	7.8	2500	24	10	18	17	<5	20	3.6	280	600	<1	120	120	73
06/29/88		8.0	3250	36	18	14	39	<5	52	4.4	370	790	<1	160	160	68
=====																
WY 88	Min	7.8	2500	24	10	14	17	<5	20	3.6	280	600	<1	120	120	60
	Med	7.9	3280	39	18	18	35	<5	52	4.4	380	810	<1	170	170	65
	Max	8.0	3400	43	19	56	39	6	53	4.7	430	930	<1	180	180	73
	Count	3	4	4	3	3	3	3	3	4	4	4	4	4	4	4

Map Index 0-7 .....Santa Fe - Mud Slough Diversion at Henry Miller Road (MER548)

Location .....Latitude 37 05'59", Longitude 120 49'11". In NW 1/4, NE 1/4, NE 1/4, Sec. 1, T.10S., R.10E. On Henry Miller Rd. 0.8 mi. E of Mercy Springs Rd.

Date	Time	pH	EC umhos/cm	Se	Cu	Cr	Ni	Pb	Zn	B	Cl	SO4	CO3	HCO3	Total	
															Alk.	Temp
							ug/L						mg/L			
10/01/87	1110	8.1	2950	44	5	16	14	<5	16	4.2	360	660			140	74
11/03/87	1325	8.6	2350	9.5	3	5	6	<5	8	3.6	340	570	0	170	170	62
01/27/88	1620	8.0	3850	49	5	20	8	<5	9	5.0	440	950	0	180	180	52
05/05/88	1555	8.0	3650	44	6	20	11	<5	13	4.9	390	900	<1	150	150	60
08/01/88		8.1	2700	28	4	4	6	<5	8	3.4	330	610	<1	150	150	83
09/01/88	1425		2850	31	4	5	6	<5	5	3.6	380	670	<1	150	150	90
10/04/88	1230		2000	24	6	11	11	<5	16	2.0	250	410	<1	120	120	70
11/01/88	1250	8.2	1740	11	2	2	<5	<5	6	1.7	230	310	<1	120	120	68
12/08/88	1400		2660	26	4	7	6	<5	8	3.5	300	180	<1	150	150	53
=====																
WY 88	Min	8.0	2350	9.5	3	4	6	<5	5	3.4	330	570	0	150	140	52
	Med	8.1	2800	38	5	11	7	<5	9	3.9	370	670	<1	150	150	68
	Max	8.6	3850	49	6	20	14	<5	16	5.0	440	950	<1	180	180	90
	Count	5	6	6	6	6	6	6	6	6	6	6	5	5	6	6
-----																
Total	Min	8.0	1740	9.5	2	2	<5	<5	5	1.7	230	180	0	120	120	52
	Med	8.1	2700	28	4	7	6	<5	8	3.6	340	610	<1	150	150	68
	Max	8.6	3850	49	6	20	14	<5	16	5.0	440	950	<1	180	180	90
	Count	6	9	9	9	9	9	9	9	9	9	9	8	8	9	9